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A Note on the German Foundry Industry

From a study of very recent issues of the German technical Press, it is possible to get some sort of a picture as to how the foundry industry is faring in enemy countries. There is evidently an acute shortage of executives, as the number of advertisements requiring skilled technicians has increased enormously. Quite a few addresses have been changed, but whether this is due to the attentions of the R.A.F. or not it is difficult to decide, because of the nasty habit the Nazis have of renaming streets, by using them to commemorate unknown thugs, who were killed in street brawls, at a time when the party exploited this method to obtain political domination. The technical Press, being controlled by the NS.-Bund deutscher Technik, devotes quite a large percentage of its limited space to obvious political propaganda. Here and there we think we can detect evidence that some concentration of the iron-foundry industry has taken place, because the names of small foundry owners now appear as managers in the larger establishments. Technical meetings covering foundries which were comparatively dormant during the earlier part of the war are now more active than ever. Between January 17 and May 16 no less than 88 Papers were scheduled for presentation in ten centres. A subject which keeps cropping up for discussion is the composition of cupola charges, due no doubt to the deterioration which war invariably brings about in the quality of raw materials. Naturally enough the light alloys are well featured in all programmes.

The Papers are presented at one- or two-day conferences held in the various districts. Some of these have been devoted to drying problems, and moulding sands, but "neuzeitliche Gattierungsfragen" or present-day raw material problems is the major stock subject, with Dr. Ing. habil C. W. Pfannenschmidt, of Augsburg, as the principal lecturer. Some of the advice given centres around the analysis of each wagon and entering the results upon a separate State-standardised stock card.

Each day as material is used, the necessary subtraction is made. The next hint is that it is preferable to use irons from three different wagon loads, to form a 60/40 charge instead of one. Then a warning is given against mixing high-phosphorus iron (Luxemburg) with hematite, it being preferable to use a German No. 3, taken from three different bins, and also against mixtures having widely different manganese and silicon contents. Whilst these hints appear to be elementary, we should imagine that a similar educational effort made in this country would have a beneficial influence.

Wood, suitable for patternmaking, must be in short supply in Germany, as a long illustrated article is devoted to the use of paper as a substitute. Generally speaking, however, the problems of the German foundry industry seem to be much the same as our own, but over there, a greater effort is being made by the leading technicians to diffuse information designed to overcome current difficulties. On this side, technical activity needs to be accelerated—a policy we have consistently urged.

The problem of new recruits for the industry has loomed large in recent foundrymen's meetings. The demand has outstripped the supply, and extensive arrangements have been made to train apprentices in sufficient numbers. New training schools are being planned, as that at Leipzig. To attract new entries, posters are displayed in elementary schools in Saxony, maintenance offered during training, and money prizes for particulariy successful trainees. It is evident from these trends that the German foundry industry is feeling much concern as to the skilled-labour position in the future.

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MEEHANITE RESEARCH INSTITUTE

ANNUAL MEETING IN YORK

The tenth annual meeting of the Meehanite Research Institute held in York on June 8 and 9 was presided over by Mr. N. E. Rambush. There was almost a record attendance of members representing the Meehanite Licensees in England, Wales and Scotland; there were also present Mr. John Cameron, J.P., and Mr. E. M. Currie, directors, and the staff of International Meehanite Metal Company, Limited. The chairman, in opening the session, read a letter which he had received from Mr. Oliver Smalley, O.B.E., in which he expressed regret at being unable to attend the meeting, which he hoped would be successful. Mr. Smalley made reference to the great work being carried on in the British section of the Meehanite organisation and the part it was playing in the war effort. It was agreed that a cable be sent to Mr. Smalley in acknowledgment of his message.

In the unavoidable absence of Mr. R. B. Templeton, secretary of the Institute, Mr. E. M. Currie presented the annual report, which showed that the Institute was in a very satisfactory position financially and that a large amount of valuable research had been completed during the year. The report was unanimously adopted.

The meeting then proceeded to discuss some 35 Papers and reports dealing with a variety of subjects of interest to licensees, including fettling shop methods and their efficiency; behaviour of oil sand cores under heat influence; effect of combustibility and reactivity of coke on cupola control; blast velocity in cupola control; modern machining of Meehanite including cutting tools and tool shanks made in Meehanite. There were several important Papers dealing with results of researches into the physical properties of the various processes of Meehanite; compression in as-cast and heat-treated conditions; the elastic constants in compression; the stability of Meehanite; elastic constants in torsion; Brinell hardness values at elevated temperature; the effect of austempering on higher process Meehanites. Surveys of castings required in a variety of industries and the substitution of steel castings and forgings by Meehanite were dealt with in reports presented by a number of licensees. A number of Papers dealing with various phases of foundry technique and operations were also considered.

Meetings of the Merchandising and Research Committees were also held during the second day of the meeting. Mr. E. M. Currie announced that the Meehanite Metal Corporation had instituted an ideas competition open to employees and staff of licensees; a considerable sum of money had been set aside as prizes. Details of the scheme would shortly be communicated to licensees.

Al-Cu-Ti Alloy.—R. IRMANN in "Metallwirtschaft" describes comprehensively the grain-refining action of titanium in the light of the casting properties of an Al-Cu-Ti alloy, and enumerates the best casting conditions of the alloy in sand and chills.

INSTITUTE OF BRITISH FOUNDRYMEN

ANNUAL CONFERENCE

In addition to the Papers detailed in the programme for the annual conference of the Institute of British Foundrymen, to be held in London next Saturday (see FOUNDRY TRADE JOURNAL for May 14), the following Paper will be presented at Session B:

Paper No. 753: Reports on Low-Tin and Tin-Free Bronzes and Brasses, by Members of the Non-Ferrous Sub-Committee of the Technical Committee, comprising: Foreword; Part I, Silicon bronzes as casting alloys; Part II, Properties of sand-cast low-tin content gunmetals and brasses, by F. Hudson (Member); Part III, The founding of types A and B brasses. This Paper gives an account of the present position regarding low-tin and tin-free substitutes for Admiralty gunmetal and similar bronzes as exemplified by changes in current specifications, particularly those of the British Standards Institution and the Admiralty.

Copies of this Paper will be available at the Annual Conference.

IRON AND STEEL INSTITUTE

A joint meeting organised by the Iron and Steel Institute, in conjunction with the Sheffield Society of Engineers and Metallurgists, the Sheffield Metallurgical Association and the South Yorkshire Section of the Institute of Chemistry, will be held in the Assembly Room, Royal Victoria Station Hotel, Sheffield, on Wednesday, June 24, 1942, at 7 p.m. Dr. W. H. Hatfield, F.R.S., will take the chair.

The following Papers will be presented for discussion:—

"First Report of the Standard Methods of Analysis Sub-Committee," a Sub-Committee of the Committee on the Heterogeneity of Steel Ingots, to be presented by Dr. E. Gregory, chairman of the Sub-Committee.

"On the Carbide and Nitride Particles in Titanium Steels," by W. Hume-Rothery, M.A., D.Sc., F.R.S., G. V. Raynor, M.A., Ph.D., and A. T. Little, D.Sc., to be presented by one of the authors.

GERMAN FOUNDRY ESSAY COMPETITION

Last autumn, an industrial concern in the Rhineland offered a prize for the best means of permanently eliminating the noise, dust and fumes nuisance in grey-iron, malleable and steel foundries, to such a degree as to raise the general level of cleanliness of a modern foundry operating 200 moulding machines to that normal in an up-to-date engineering shop. Nine entries were submitted, most of which are stated in the report published in "Die Giesserei" of January 9 to have contained valuable practical suggestions. Five entries were placed on the short list and prizes of 1,000 Rmk. each awarded to the authors of two of the Papers, which will probably be published in the German Press shortly.

SAND CASTING OF SILICON BRONZES AND P.M.G. METAL

Part B.—The Manufacture and Properties of P.M.G. Metal: Conclusion of Paper and Report of Discussion

By W. MACHIN, O.B.E.

(*Continued from page* 159.)

Contraction Problems

Contraction Allowance.—It has been found in practice that this is very close to gunmetal, that is between $\frac{1}{8}$ in. and $\frac{3}{16}$ in. per ft. Here again the type of job controls this matter to some extent, but if the practice be followed as for gunmetal good results should be obtained. As to the important question of contraction of castings made in silicon bronze, it has been found that P.M.G. metal contraction operates at a much greater speed than is the case with bronzes containing tin. In cases of castings which are made in this alloy and are fairly long, made in dry sand moulds, care should be taken to allow the casting to shorten by slackening or easing the sand away from the front of the feeders and runners immediately after solidification.

The explanation given seems fairly clear, but to simplify it Fig. 14 has been prepared, which shows a moulding box with the feeders marked "B," "B1," "C" and "C1." The runners are marked "D" and "D1." The contraction is in the direction of arrows marked "A," therefore the sand in front of the feeders marked "E" should be slackened away with the use of a thin steel bar, thereby preventing contraction being retarded at these points.

The contraction of castings in all metals, including steel, cast iron, and non-ferrous alloys of any type, requires to be carefully attended to, as will be seen in the diagram in Fig. 15. This figure shows that contraction movements can be the cause of considerable trouble. It is of great importance, where silicon bronzes are concerned, to ensure that contraction is not retarded, as it operates more rapidly than is the case with other brasses or bronzes.

A good idea to adopt in the case of long castings made in dry sand is to make the mould and cores on flimsy lines in front of flanges, as shown in Fig. 16. The cavity shown in front of the flanges in the mould does help considerably in the case of dry-sand moulds, for castings of 3 ft. or over in length. Components up to 25 ft. in length have been cast in silicon bronze, and before the practice detailed was used, trouble was experienced with contraction cracks, which disappeared after the precautions indicated had been carried out, and good castings were afterwards obtained.

The word shrinkage is sometimes used for contraction, and this word can cause confusion in technical circles, because liquid shrinkage occurs in a feeder or riser. However, the subject referred to here is the contraction which takes place just after the pasty stage down to a cold casting. Where moulds are made by either the green-sand or skin-dried methods, there is no need to take

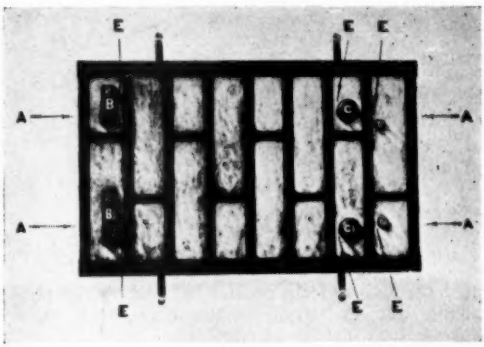

FIG. 14.—MOULDING BOX WITH POSITION OF RUNNERS AND FEEDERS.

any extra precautions to combat contraction. Experience has shown that a perfect casting, if there be such a thing, can be made by such methods without any contraction troubles.

Short Freezing Range Undesirable

The metal has been referred to as having a short freezing range, by those who have been laboratory trained, and possess no foundry practice or experience. These individuals have often stated that, due to this, the metal is a good casting alloy—a very widely held theory. In the author's opinion, it is untenable, unless other conditions, such as the inevitable contraction, are correct. All metals with short freezing ranges, *i.e.*, those which set very

P.M.G. Metal : Manufacture and Properties

quickly, are more difficult to handle in practice so far as contraction problems are concerned, than are those with longer freezing ranges. This is due, in the author's opinion, entirely to the metal not being sufficiently long in contact with the surface of the mould and cores to soften them before the pasty stage of the metal has been reached, after which stage contraction commences to occur.

It will be appreciated, therefore, that this is the main reason why the point of making the cores as flimsy as possible has been stressed. They assist in their heating up, and so help the contraction to take place without hindrance. It should not be thought that P.M.G. metal or silicon bronze is the only alloy that should be controlled for contraction, as the same feature is very important in the case of gunmetal. Many jobs have been rejected through defects caused by holding the contraction due to strongly-made cores with thick walls of sand instead of thin ones.

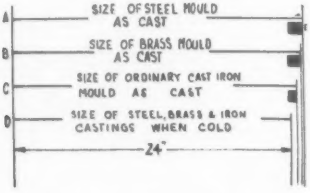

FIG. 15.—COMPARATIVE CONTRACTION OF CAST METALS.

A study of high-phosphoric iron, which is liquid in the mould longer than many other metals, reveals, in the case of rain-water pipes, that these castings cannot be considered as simple where this important question of contraction applies. However, trouble is never encountered, as the cores are heated up by the metal having a long freezing range, and therefore the contraction is taking place on a soft centre or core due to the time lag before freezing commences. If the reverse order existed in this instance and the iron had a short freezing range, there would probably be much more trouble from contraction with these pipes than exists today.

There are many opinions regarding this question of freezing ranges of materials which are melted to cast, and it is a very important subject. In the author's opinion, it does not follow, as has been suggested by many, that metals with short freezing ranges are the best for making good castings, unless the practical foundryman makes his contribution as explained.

Scrap Remelting Data

The warning is again repeated that separation of P.M.G. scrap is of the utmost importance, and on no account must it be mixed with other non-ferrous metals. The necessity of keeping P.M.G. metal scrap separate must be rigidly adhered to. P.M.G. metal scrap is of a reddish colour, and can therefore be easily selected and separated from other scrap in the dressing shop. If great care be taken in this respect and the metal is kept entirely separate from other brass, it can be remelted repeatedly with very small melting losses, and with no detriment to its casting or mechanical properties. It is, of course, necessary to see that melting temperatures are kept within the range detailed earlier. As an example of this, the following

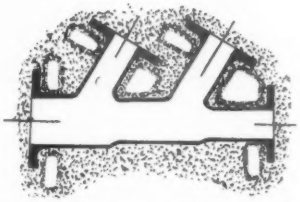

FIG. 16.—METHOD FOR LONG DRY-SAND CASTINGS.

figures (Table I) show the losses of each of six melts, starting with 150 lbs. of metal.

The average loss per melt of the above works out at 0.66 per cent., the gross weight of the metal cast on the first melt was 150 lbs., and the gross weight of the metal remaining at the end of the sixth cast was 144 lbs. The tests which were carried out from these six melts gave the results set out in Table II.

It is noteworthy that at the conclusion of the sixth melt the analysis was practically identical with that of the initial melt, the ingredient loss being negligible. The second column in the above table indicates the temperatures at which P.M.G. metal may be cast without any fear of deterioration or lessening of the mechanical properties. Thus, scrap may be repeatedly melted, the loss being negligible.

The information on test results so far given is but a very brief account, and many other tests have been carried out, the details of which can be made available if there be a real demand. It is of interest to note that P.M.G. metal has been used

extensively in the past, and no less than 40,000 castings have been made in the completion of five ships. The "Strathnaver," for instance, had 7,562 miscellaneous castings incorporated in its make-up, whilst one gunboat had no gunmetal aboard.

In conclusion, the author expresses thanks to Sir James Callander and Sir Robert Beeman for permission to use the photographs and other information connected with the subject.

TABLE I.—*Melting Losses of P.M.G. Metal as Revealed by Repeated Remelting.*

No. 1	Original weight	150 lbs.	
	Weight of test bars	14¼ ,,	
	Weight of ingots left	133 ,,	
		147¼ ,,	
	Loss	2¾ ,,	=1.83 per cent.
No. 2	Weight of ingots melted	133 lbs.	
	Weight of test bars	29¼ ,,	
	Weight of ingots cast	102 ,,	
		131¼ ,,	
	Loss	1¾ ,,	=1.32 per cent.
No. 3	Weight of ingots melted	102 lbs.	
	Weight of test bars	14¼ ,,	
	Weight of ingots cast	87 ,,	
		101¼ ,,	
	Loss	¾ ,,	=0.74 per cent.
No. 4	Weight of ingots melted	87 lbs.	
	Weight of test bars	12¼ ,,	
	Weight of ingots cast	74 ,,	
		86¼ ,,	
	Loss	¾ ,,	=0.86 per cent.
No. 5	Weight of ingots melted	74 lbs.	
	Weight of test bars	14 ,,	
	Weight of ingots cast	60 ,,	
	Loss	Nil.	=Nil per cent.
No. 6	Weight of ingots melted	60 lbs.	
	Weight of test bars	40 ,,	
	Weight of ingots cast	20 ,,	
	Loss	Nil.	=Nil per cent.

DISCUSSION

The PRESIDENT was sure the members appreciated the clear and concise nature of the Paper. After hearing it, it raised the question as to why such bronzes had not been more generally used in this country. Probably present-day conditions would bring about an alteration in that respect.

Vote of Thanks

MR. A. PHILLIPS (Manchester), in proposing a vote of thanks, said credit must be given to the lecturer as a pioneer in the use of silicon bronzes in this country, and for his willingness to describe how they could be utilised. They were all aware that Mr. Machin had incorporated a great deal more in his Paper than he had read to the meeting, but it was hoped they would have the pleasure of reading it in full in THE FOUNDRY TRADE JOURNAL later.

TABLE II.—*Tensile Properties of Remelted Metal.*

Casting Temp., deg. C.	Melt No.	M.S. Tons per sq. in.	Y.P. Tons per sq. in.	E. per cent. on 2 in.
1140	1	19.2	11.6	10
	1	18.8	10.4	
1,180	2	20.0	12.4	9
	2	20.8	12.0	11
1,140	2	20.0	11.6	10
	2	20.0	11.6	10
1,140	3	20.0	11.2	10
	3	20.4	11.6	9
1,140	4	20.4	12.0	9
	4	22.0	11.6	13
1,140	5	19.6	11.6	10
	5	19.2	11.6	10
1,160	6	21.2	11.6	13
	6	21.2	10.8	13
1,140	6	21.6	12.4	11
	6	20.8	11.6	10
1,130	6	20.8	11.2	12
	6	22.0	11.6	13
	6	21.2	11.2	12
	6	20.0	12.0	11

MR. W. BROWN (Manchester), who seconded, speaking as a brassfounder, said he could also claim, in a small way, to be an early experimenter in the use of silicon bronzes. In July, 1930, the foundry with which he was then associated did much work in regard to them. One job was an eight-way steam valve with, he thought, a pressure of about 2,000 lbs. of steam. They had always made this particular valve in Admiralty gunmetal. On this particular occasion the firm were informed that the metal would be supplied to them in the

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form of P.M.G. metal. When the ingots were received, he did not altogether like the look of them from a foundryman's point of view, so he inquired what was the best practice. The reply was that the usual practice with regard to Admiralty gunmetal would more than suffice. They proceeded to make the valve, which was about 8½ cwts., if he remembered rightly, using the same procedure as with Admiralty gunmetal. He was afraid Mr. Machin would have been very disappointed with the result; it was a complete failure. In the case of a second one, they adopted their own methods and followed, more or less, the manganese-bronze practice. The casting was made successfully, and, as far as he was aware, it was in operation at the present time.

The vote of thanks was carried unanimously by acclamation.

MR. MACHIN, in acknowledging, said that, as regards the remarks made by Mr. Brown concerning manganese-bronze practice, in the early stages the metal was handled by the laboratory in regard to sales and development. They had on many occasions sent their foreman to foundries to put them in touch with the characteristics of the alloy when they sent it away, and there was never any trouble experienced when that was done. To state that it could be cast the same as gunmetal in the feeding arrangement was incorrect. There must be ample feeding arrangements provided, mainly on account of the short freezing range. It shrank away peculiarly and was not like gunmetal in this respect, and it had not a dendritic appearance on the top of feeders like gunmetal. The alloy contained all high-melting elements which cooled very quickly towards the solidification point. If the metal was properly fed and properly run, there should not be any trouble with it at all, or no more than is the case with gunmetal. Trouble had been experienced with it, but in the light of the experience which was now available, it could be cast quite as well, or in many cases better than gunmetal.

Running Methods

MR. A. HOPWOOD (Liverpool) referred to the running or the distance at which the metal would travel. In the case of an 8-ft. casting of five-sixteenths metal, containing, say, 1½-in. flanges, which was quite a usual thing in shipping circles, did Mr. Machin prefer to use the method of sprays or to use a large number of down-runners through the top parts? Coupled with this point, of course, came the question whether the metal would top run quite successfully. From what experience he had had, he thought it would, namely, that the metal could be dropped straight into the mould in a similar manner to the dropping of gunmetal. He assumed that the tail shaft liners referred to in the Paper were run flat, with the usual method of runners along the joint. He did not quite understand the failure of the tail shaft liners and the *lignum vitæ* supports for the shaft, and would be pleased to receive a little information upon the point.

MR. MACHIN assumed that Mr. Hopwood meant, when he referred to the running distance, the distance from the flange.

MR. HOPWOOD said he meant the distance the metal would run and keep lively.

MR. MACHIN replied that it could be run up to any length, to 30 ft. if necessary, without any trouble. The liners mentioned were cast vertically, not horizontally. He never cast tail shaft liners in silicon bronze horizontally, but always vertically, while in gunmetal they were cast horizontally. With silicon bronze, the runners were spaced round the top, just as a liner would be cast in iron. The runners were spaced three or four inches apart all round the top. The metal was put into a basin and released very quickly, and the quicker it was cast the better.

The metal would travel any length within reason, as it was very fluid whilst hot; the castings came out very sharp from the mould, and there was no trouble in that respect. Nor was there any trouble in running if the correct temperature was maintained, and there was a wide range of temperature available, *i.e.*, 1,000 up to 1,150 deg. C.

Regarding top runners direct on to the casting, he did not use them; he did not say it was not right to do so, but he usually ran straight into the flange to keep all the metal together or in a pool when filling the mould. When there were seven or eight sprays on a valve, it was not possible to plug the runners, as in the case of a one-plug runner. It was usually arranged to run through the flange, and little trouble was experienced.

Tail Shaft Liner Bearings

Turning to the question concerning wear on *lignum vitæ* strips, looking at the structure of the metal, at 200 magnifications, it would be found that there were a considerable number of spots in the matrix, which could be seen very clearly; these, in the author's opinion, were a silicon-iron alloy which may be slightly abrasive. It had been argued by several metallurgists that the alloy would run satisfactorily on white metal bearings. Personally, he did not know whether it would or not; he

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thought that probably it would, but definitely it would not run on *lignum vitæ*. There was something abrasive about the alloy, so that, after a certain amount of running, there was a scoring of the *lignum vitæ*, and instead of the ship coming back from a voyage with a round bush, it was found to be slightly oval. In view of this, the application of silicon bronze for a tail shaft liner was discarded in favour of gunmetal.

No fault could be found with the castings in regard to quality or on pressure tests, or when they were being machined. Again, the rubbing away of the *lignum vitæ* strips, may probably have been due to there being a little free silicate existing somewhere in the casting. This failure was experienced in, he thought, three or four ships, although liners in silicon bronze were fitted in many more ships. Of course, it was a big job to take out tail shaft liners and put in new ones. The rubbing away took place in the case of ships doing 20 knots or over travelling to and from Australia, and, in his opinion, this was a very severe test for silicon bronze on *lignum vitæ* strips. On slower-running ships it may have proved to be satisfactory. Gunmetal no doubt is ideal for this application, but silicon bronze, due to the scoring action, proved unsatisfactory. Why wood was used in the bushes he did not know, as all the Admiralty ships were fitted with white metal. It was sufficient for the Admiralty to know the application was not good with wood; therefore, they naturally would not risk running them on white metal, and, in the author's opinion, it was a correct decision to make.

MR. W. N. COOK, B.Sc. (Manchester), asked if castings had been made in open sand, to which Mr. Machin replied in the affirmative.

Making the Hardener

MR. MACHIN, continuing, said some members had inquired the best way to get the tin substitute or hardener. If it had to be used throughout the country, the best way in his opinion was to go to someone dealing with the melting of alloys, as the hardener must be manufactured on sound metallurgical lines. If the iron, silicon, copper and the manganese were not properly alloyed, trouble would ensue in the final alloy. There was no time in the present emergency for experiments in the preparation of the hardener by any foundry.

Leaded Silicon Bronzes

MR. A. PHILLIPS (Manchester) said that apparently one of the chief difficulties with regard to silicon bronze was the formation of silicates. A similar trouble was experienced in regard to aluminium silicon alloys. In the manufacture of the hardener did Mr. Machin reduce the stirring? For instance, speaking offhand, if lead was present then lead silicate would soon form, and by stirring it greater trouble would be caused eventually, because it would be stirred into the metal. Owing to the specific gravity of the silicate it would remain suspended in the metal. Therefore there would be hard spots in the castings when they came to be machined. This was, of course, merely theorising. When manufacturing the hardener, did Mr. Machin stir the metal as little as possible or did he stir it much; also did he find he had to stir it under a flux? What method did he use to avoid making a silicate, because that appeared to be one of the chief difficulties in the making of the alloy.

MR. MACHIN said the hardener had the most silicon in the melt. Mr. Phillips had brought forward a particularly important point; silicates would form if the melting was not properly looked after. As shown on the screen there should be half the silicon in the bottom of the crucible and all the copper on the top. The copper commenced to melt before the silicon started, so the silicon was therefore covered just on the pasty stage with copper, only little stirring was done, a start was made to melt the hardener as shown with a 300-lb. pot, the charge was put in and the pot was kept covered all through the melt. At a given time the lid was taken off, the phosphor copper added, then it was lightly stirred. The melt was then allowed to remain another 10 mins., and then taken out and cast into ingots. There was 100 lbs. of hardener melted in a 300-lb. pot, this method eliminated a lot of stirring. When the lid was put on the crucible it was not touched for about 1¼ hrs.; it took roughly 2 hrs. to melt. If the crucible were left uncovered during the melting of the various elements in the hardener, the silicates mentioned by Mr. Phillips would appear because more stirring would be necessary due to the melt being delayed which caused some of the constituents to stick to the pot side.

Lead Addition to Alloy

Lead had been added to the alloy quite successfully, up to 10 per cent., but it was a tricky job. Only a little stirring was done and the casting operation was carried out very quickly, to prevent segregation in order to get a good structure. He regretted that he had not brought some fractures of the metal with him containing lead, but they could be forwarded if the members desired to use

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or see them. They were very interesting to see.

A number of bearings were made for a wire mill in 8 per cent. lead silicon bronze, the scrap was returned and it was expected that it would be paid for on the same ratio as phosphor bronze. Upon using it again it was found that the pressure under which the bearings had been operating in the mill had caused a certain amount of small cracking to occur. Oil had percolated into the cracks, and was the cause of a considerable amount of trouble occurring in regard to the melting of the scrap. With 3 per cent. of lead in the case of many bearings the alloy had worked successfully and there was a perfect structure in the fractures. Microstructures had shown the lead to be perfectly alloyed.

Bearing Metals

MR. A. DUNLEAVY (Newark) hoped the members of the Branch would not go away with the idea that it would be necessary to turn over to the use of silicon bronze straight away. Tin stocks might yet last for three or four years. So that the making of their own silicon bronze was a question of internal policy. He thought it was generally admitted that silicon bronze was not suitable for bearings, but he would rather deal with a more important point, namely, the contamination of many bronzes by silicon bronze scrap, or the contamination of ordinary gunmetals by silicon bronze and the contamination of silicon bronze by the tin in phosphor bronze. He would like to hear an expression of Mr. Machin's views upon the point. How could he separate the two scraps not only from the fettler's shop, but also from the machine shop? Also, would Mr. Machin give some information regarding the rotary furnace atmospheres and silicon bronze. Was there the same action as would be obtained through the crucible? Contamination of a furnace atmosphere was an important matter, particularly from machine shop scrap.

Scrap Segregation

MR. MACHIN repeated his statement that the best plan to avoid contamination was to keep the contaminating substance out. Some people said that small percentages of tin would not do any harm to mechanical properties. This was correct up to a point. The mechanical properties were equal to the required Admiralty specifications, but it was detrimental to the casting especially for pressure applications.

Dealing with the segregation of scrap, it could be definitely separated in the foundry. Colour was a sufficient indication. Silicon bronze or P.M.G. metal showed red in the machine shop, therefore the silicon bronze could be picked out quite easily from gunmetal borings. No concern need be felt regarding furnace atmosphere provided the metal was kept covered, charcoal being satisfactory. It could be melted in a rotary furnace, but he did not think that furnace was a good type to melt silicon bronze. If the metal was not kept covered it would have an affinity to pick up oxygen very readily at high temperatures. He thought it would be quite in order to handle gunmetal, silicon bronze and manganese bronze in one foundry, each of them being kept in a separate part of the shop. He was definitely of the opinion that the presence of tin in silicon bronzes was not good.

PUBLICATIONS RECEIVED

Cleaning Machinery.—The subject of blast cleaning of castings in its diverse aspects is comprehensively dealt with in a catalogue just issued by H. G. Sommerfield, Limited, of 8, Camden Road, London, N.W.1. After an introduction showing the main differences incorporated in the design of their plants, the brochure gives a wealth of data relative to the pressure chambers. It then deals with the standard room plants; rotary tables; cabinets and barrels. Under the heading of specials, there is a clear description of a plant specially designed for the automatic cleaning of cylindrical components, both internally and externally. Section 8 covers the important question of dust arresting, the type described incorporating a series of fabric bags, whilst Section 9 discusses nozzles, hose and helmets, articles of which this firm has had many years of experience. Some good working data are included in the chapter dealing with compressors. Especially useful is the information connecting the air pressure with the type of abrasive used and the articles to be handled. Stress is rightly laid, in the final section, on the servicing of sand-blast plant, for much of the successful operation of the machine depends upon its initial putting into commission. An appendix takes the form of an instruction sheet, of the type to be pasted on a board, varnished and displayed conveniently near the plant. It is suggested that the paragraph referring to lubrication should be printed in bolder type. This advice is based on general experience with the industry! The brochure is written in a pleasing style, which makes it much more interesting to read than the general run of catalogues. It is available to our readers on application to the issuing house.

SAVE EVERY SCRAP OF WASTE PAPER!

CUPOLA-MELTED HIGH-DUTY CAST IRONS

FALKIRK SECTION DISCUSSION

Eash's Theory of Undercooled Graphite Formation—Author justifies the term "Reticular Graphite" and accepts Eash's conclusions

(*Continued from page* 165.)

From the appearance of the graphite structures illustrated by Mr. Braidwood, it would seem that his test-bars had been poured with a very small temperature interval between the pouring temperature and the freezing point of the iron. Thus the flake graphite in the inoculated irons tended to assume a random distribution. In the case of his irons with undercooled structures, as a result of relatively low pouring temperatures, the dendrites were small and equiaxed, and in the particular cases quoted by the investigator presented a reticulated appearance. The real danger in the use of the term reticular rested in the fact that all undercooled structures might be thought to be distributed in this manner. Actually, with higher pouring temperatures, the reticular pattern disappeared and the graphite became manifestly inter-dendritic.

The term "reticular" defined the appearance of the structure rather than the mode of formation of the structure. When appearances were concerned, it was well to consider the relationship between the polished surface of the microspecimen and the three-dimensional distribution of the constituents. For instance, a certain spot in a microspecimen must have a reticular appearance because the surface of the microspecimen cuts the arms of the primary dendrites. In this context it was always advisable to examine these graphite structures at the lowest power possible, in order to appreciate the extra-dendritic pattern of the graphite.

It is interesting to note here that an inoculated iron was not essentially different from an ordinary cast iron. It was not possible to view an iron under the microscope, and to say "this iron has been inoculated." As far as the structure was concerned, inoculation merely guaranteed the absence of undercooled structures.

Eash's Theory

It was somewhat disconcerting to find that the author appeared to have accepted unconditionally the conclusions drawn by Eash from his experimental work. The work carried out by Eash was excellent, and his theory, which was apparently backed by irrefutable experimental work, that undercooled graphite was formed by the decomposition of white iron and that normal flake graphite was formed directly from the liquid, was extremely fascinating, but before it was completely accepted, certain known facts needed lining up with this theory. It appeared that Eash had completely overlooked a few details which, if not disproving his theory, certainly needed much imaginative explanation in terms of this theory, or which tended to restrict his explanations to the castings made under the isolated conditions of his experiments.

First, it is a well-known fact that it was possible to produce either normal or undercooled graphite structures in high-silicon irons. It was well known that 4 to 6 per cent. silicon irons of the Silal type when correctly made had an undercooled structure. Further, undercooled structures could also be obtained at will in the corrosion-resisting irons of the 10 to 15 per cent. silicon class. Are metallurgists to assume that undercooling in these irons with 5 to 15 per cent. silicon occurred according to a different mechanism from that in the lower silicon irons, or were they to assume that iron carbide formed even though momentarily in an iron containing 15 per cent. silicon? If iron carbide was an essential intermediate between the melt and the undercooled graphite structure it would be expected that undercooled structures would be more difficult to realise in high-silicon irons.

Secondly, it had been shown that by treating the metal with titanium and carbon dioxide it is possible to produce undercooled structures in 3 to 3.5 per cent. carbon and 1 to 3 per cent. silicon irons of 6-in. section and more. Again, had one to assume the momentary stability of iron carbide at temperatures and with cooling rates and compositions of such an order that even the momentary stability of iron carbide became questionable?

Undercooled Structures and Mechanical Properties

It seems strange that the author found that the presence or absence of undercooled structures exerted no dominant influence upon the mechanical properties with the exception of resistance to impact. In personal experience, the presence of an undercooled structure produced low mechanical strengths all round. One of the reasons why ladle inoculation gave improvements in tensile and transverse strength was the removal of the undercooled

structure. However, since undercooled structures tended to give poorer mechanical properties it should not be thought that irons having these structures could be dispensed with entirely. It had been clearly shown that heat-resisting irons, such as Silal and Nicrosilal, resisted oxidation more efficiently when the graphite was in the undercooled form. Furthermore, in making a casting it was sometimes necessary to compromise between good mechanical properties, soundness, that is freedom from porosity, and uniformity of structure throughout a given section. For instance, at the B.C.I.R.A., the staff had to make some solid blocks measuring 8 by 5 by 7½ in., and it was essential that the castings should have fairly good mechanical properties, and at the same time show absolute freedom from porosity at the centre of the blocks. In order to achieve this the blocks were made in an alloyed iron.

The presence of nickel and molybdenum guaranteed fairly good mechanical properties. The molten metal was treated with titanium and carbon dioxide to give castings containing a wholly undercooled structure. The resultant blocks were absolutely free from internal porosity and were of uniform hardness. The Brinell hardness numbers obtained across a section cut from the centre of a trial block were (from edge to centre) 205, 201, 197, 203, 197, and 201.

AUTHOR'S REPLY

Mr. Braidwood wrote that the communication from the British Cast Iron Reseach Association was a greatly appreciated contribution to the discussion of his Paper. His reply should begin with a justification of the choice of the term "reticular" to describe graphite of the characteristically arranged, fine-flake type which questioners preferred to call "undercooled" graphite. The several alternative terms, in descending order of dislike, are dealt with below:—

"*Eutectic*" *Graphite.*—This description would apply to graphite precipitated from the liquid as a constituent of a eutectic. Therefore, graphite of the type under discussion, which was evidently formed from the solid, had no claim to this title. Actually, "eutectic" graphite was graphite of the normal flake type such as was present in ordinary grey irons, and the use of this term to identify graphite of the type under discussion was positively misleading. This has been stressed by Eash.*

* A.F.A. Preprint No. 41-9, p. 16.

"*Eutectiform*" *Graphite.*—This meant "having the appearance or form of a eutectic," and, as had been pointed out by Flynn and Reese,* this term was vague and might even be confusing by reason of the many known forms of eutectic structure.

"*Dendritic*" *Graphite.*—As Mr. Morrogh has himself indicated, this description was quite incorrect. Where graphite of the type under discussion was present, it was the matrix that was dendritic, not the graphite. "Inter-dendritic" or "extra-dendritic" were the terms really justified.

"*Abnormal*" *Graphite.*—Personally reported experiences had shown that graphite of the type under discussion was not abnormal in low-carbon irons; on the contrary, it was precisely that form of graphite which would almost invariably be present unless special measures were adopted to ensure its absence. In low-carbon irons, therefore, such graphite was actually the normally-occurring type and the proposed term became dangerously indefinite.

"*Supercooled*" *or* "*Undercooled*" *Graphite.*—Strictly speaking, it was not the graphite that was undercooled, but the metal from which such graphite was subsequently liberated. The term, therefore, was not precise. It might be argued, of course, that, since undercooling was observed to be associated with the formation of such graphite, there was justification for the use of this term. It would not be correct, however, to assume that such graphite was produced because the metal had experienced undercooling. It was very probable that undercooling of the melt and formation of this fine graphite were mutually the result of the operation of some other factor, for example, the absence of nuclei.

"Reticular" Graphite Justified

What objection was there to the use of the term "reticular" graphite? Mr. Morrogh stated, incorrectly:—"The term 'reticular' defined the appearance of the structure rather than the mode of formation of the structure." That really should have read:—"The term 'reticular' defined the appearance of the graphite distribution rather than the mode of formation of the graphite." Precisely! And that, at the present time, was its chief virtue. When, at last, some single theory of graphite formation was proved completely and accepted universally, technically-perfect terminology might be framed by common consent. Meanwhile, and so long as metallurgists continued in the midst of an almost bewildering whirl of theories and counter-theories, it was surely wise to avoid all reference to assumed modes of formation and use

* A.F.A. Preprint No. 41-14, p. 9.

terms descriptive of appearance only, yet sufficiently definite to make clear distinctions possible. The term "reticular graphite" can be so classified. (The writer does not claim to have coined this term; it was used several years ago by Dr. Nipper,* or his translator.)

Since all graphite in grey iron was in the form of flakes, whatever their distribution or relative size, the unsupported term "flake" graphite was inadequate. Similarly, and for reasons already listed, the description "normal" graphite was not sufficiently definite. Objection to the use of "random," however, was mild, as was evidenced by its frequent appearance, for the sake of variety, in the Paper.

Inter-dendritic Arrangement of Graphite

Mr. Morrogh declared that all graphite flakes were in inter-dendritic arrangement, and claims that this could be proved by microscopical examination of suitably-etched specimens. This information was welcomed, since personal inability to trace inter-dendritic distribution in adequately inoculated low-carbon irons very much puzzled the author. In such irons the dendrites of austenite must be present in considerable proportion at the instant of solidification of the eutectic liquor, and the graphite should be located in the interstices. The micrographs, however, gave little evidence of such distribution.

He was perfectly ready, nevertheless, to accept Mr. Morrogh's assurance that by suitable etching and more expert interpretation, inter-dendritic distribution of graphite could be confirmed microscopically in all cast irons, and he considered that Mr. Morrogh had made out a good case against any use of the terms "grain-boundary," "inter-dendritic" or "extra-dendritic" graphite. When, however, he asserted that, since the distribution of his "normal" graphite was really inter-dendritic, the use of the term "random" graphite was unjustified, he could not agree. Concentrate only on the description of appearance and "random" graphite was seen to be an eminently fitting title.

The Eash Research

The recent Paper by Eash was, from a personal point of view, a first-class contribution to contemporary metallurgical research, and that author's deductions provided a simple working hypothesis which served to explain personal observations. It was not correct, however, to assume that the author had "accepted unconditionally" the conclusions drawn by this investigator. It was difficult to conceive of the existence of undissolved particles of graphite in an unsaturated melt. Nevertheless, it must be remembered that the equilibrium solubility was not the only factor which operated in practice, and there was much evidence to support the postulated existence of graphite nuclei. If undissolved particles of graphite were indeed present in the melt, increase in temperature or maintenance at constant high temperature should each promote solution. By experiment it was found that those effects which could logically be attributed to the presence of graphite nuclei did actually diminish on superheating of the melt, or on holding at constant high temperature. That was circumstantial evidence only, but there was more positive proof available.

In their recent Paper,* Massari and Lindsay reproduced micrographs of the structure of quenched droplets of hypo-eutectic irons. At high magnification these reveal the presence of graphite nuclei, and the authors demonstrated that the graphitising behaviour of any of the irons examined is proportional to the concentration of nuclei found in such specimens. It might, of course, be argued that even evidence such as this was not absolute, since, in the short period of time required for quenching of these droplets, tiny particles of graphite might be precipitated.

Yet even such scepticism did not render the nuclear theory untenable. In his contribution† to the discussion of a Paper by Norbury and Moran Dr. Desch stated that:—"... there was a good deal of evidence to show that in a molten alloy of iron and carbon, there were present molecular groupings which corresponded with iron, with iron carbide and with graphite. Those molecular groupings would be destroyed as the temperature was raised. In inorganic chemistry there were many examples of that survival up to a certain point and gradual vanishing with superheating, and it seemed that those molecular groupings which had not yet reached the stage of having crystallised out of solution did furnish the requisite nuclei."

It appeared, therefore, that the nuclear theory, to which Eash and most of his transatlantic contemporaries subscribed, could be very strongly supported indeed.

Eash's Graphite Conclusion Accepted

Of the correctness of Eash's conclusion that graphite of the fine, reticular type was formed in

* "Graphite Formation and Structure in Cast Iron" H. Nipper, I.B.F. Proceedings, Vol. XXVII.

* "Some Factors Influencing the Graphitising Behaviour of Cast Iron." Massari and Lindsay, A.F.A. Preprint No. 41-7.

† Journal, Iron and Steel Institute, 1936, 1, p. 347.

Cupola-Melted High-Duty Cast Irons

the solid while random flake graphite was precipitated from the liquid, he had no doubt whatever. Surely, it was this fundamental difference which produced the striking disparity in the size of the respective individual flakes and which caused grey irons with reticular graphite to be more dense and to exhibit greater contraction than irons of similar analysis containing random flake graphite.

It is also his conviction that in irons of the type used by Eash, as well as in irons such as were described in the Paper, graphite of the fine, reticular variety was formed by the breakdown of meta-stable carbide. It was certainly doubtful, however, that carbide would be formed, even momentarily, in high-silicon irons such as were quoted by Mr. Morrogh, and there was possibly a very real need for a series of quenching experiments on irons of this type, on the lines of the procedure so successfully developed by Eash. Might not this be a line of research which could profitably be undertaken by the Association?

He (the author) fully realised that his findings with regard to the tensile strengths of those irons containing reticular graphite were not in agreement with expectation nor with the reports of other investigators. It did seem illogical that a structure offering poor resistance to impact should possess high strength in tension, but the same phenomenal behaviour was exhibited by temper-brittle steels. These might have excellent tensile strengths and elongation values, yet fail wretchedly under impact. He entirely agreed with Mr. Morrogh that inoculation simply ensured the absence of reticular graphite and did not produce any exclusively characteristic effect upon the micro-structure.

From examination of the micro-structures featured in the Paper, Mr. Morrogh had deduced that the test-bars were poured at rather low temperatures. Actually, this was not the case, the aim throughout being to pour each bar at an observed temperature of approximately 1,300 deg. C. Maintenance of this pouring temperature, which represented fairly hot metal, ensured adequate fluidity and standard pouring conditions in all instances. It was possible, however, that the use of a long narrow ingate (see Fig 2 of the Paper), designed to give slow pouring and appreciable temperature drop between basin and mould, had been responsible for the effects noted by Mr. Morrogh. All of the temperatures quoted were uncorrected readings made on a Cambridge optical pyrometer of the disappearing filament type.

Impact Testing

The single-blow impact test, conducted as recommended by the Association, had proved to be both reliable and informative; indeed, the main finding of the Paper was based upon the information which this test had afforded. Almost invariably there were two indentations in the detached portion of the specimen. These were located on the near face, one directly above the other and about 1 in. apart. The upper was the groove resulting from the impingement of the hammer; the lower was a smaller impression evidently caused by the bouncing of the detached portion against the rear of the hammer. Markings on the flat upper surface of the vice and a corresponding dent on the top, far rim of each specimen, confirmed this verdict.

It was of interest to record that no secondary impression was found on specimens of the austenitic irons which were relatively ductile and possessed of high resistance to impact. The top portions of such specimens, apparently, did not break off so sharply and did not bounce with sufficient rapidity to make contact with the out-swinging hammer. Formation of the secondary indentation did not appear to affect the reliability of the results obtained. A determination of reproducibility of results, conducted at the outset by the breaking of several identical specimens, gave very concordant figures, and all duplicate tests yielded values which were in close agreement.

In its present form the test was of very real worth. It would be an advantage, however, if the values generally obtained were greater, and less cramped toward the lower end of the standard Izod scale. Improvements, therefore, would probably follow from increase in the cross-sectional area of the specimen or from reduction of the striking height. Moreover, since the absolute accuracy of the result must be affected, however slightly, by the formation of the secondary indentation, some preventive adjustment was necessary before the test procedure can be recommended for standardisation. It was probable that alteration of the upper surface of the vice, from a flat to a sloping face, might achieve this object.

For the unwitting failure to acknowledge the notable exploratory work carried out by the Association, and particularly by Dr. Norbury, due apologies are tendered. The complimentary references made by both correspondents to the practical value of the Paper are much appreciated.

Mr. H. S. Simpson, the immediate Past-President of the American Foundrymen's Association, in his valedictory address, stated that he expected the U.S. production of castings this year to exceed the 1941 figure by 25 per cent.

JOINT PRODUCTION COMMITTEES

CO-OPERATIVE MOVEMENT TO INCREASE THE OUTPUT OF WAR MATERIAL

In total war everything and every individual has one main function—to make war. Men, women, material, mind, will and character should all be mobilised against the enemy, and the very institutions on which the State is founded be used as weapons of attack. It is for this reason that Joint Production Committees, whatever they achieve or fail to achieve, are of very great importance and are given extensive treatment by P.E.P. (Political and Economic Planning) in a broadsheet entitled " Production Committees."

In the engineering industries Production Committees are new and untried. Like all new things, they are subject to suspicion and hostility in many quarters. Some employers are liable to resent their formation on the grounds that they represent an attempt to interfere with managerial functions. But the importance of Production Committees does not lie only in the degree to which they improve the organisation of production; they should also be judged by the changes they effect in the attitude of workers' and managements to each other in production relations.

Growth of Production Committees

There was no striking development of joint consultation for eighteen months or more after the outbreak of war in September, 1939. Old attitudes persisted. The Craft Unions certainly showed themselves willing to relax restrictions on admission of new labour to industry, on dilution by women and on the upgrading of less skilled workers. But many trade unionists, for whom disputes had been the sole reason for meeting the management, felt that improvements in efficiency would only go to increase profits, and were therefore the sole concern of the company, while many managers of factories were unwilling to allow any trespass on their managerial functions. There was little real enthusiasm on either side. Both employer and employee tended to remain on the defensive.

Pit Production Committees.—The Pit Production Committees, representing miners and management, were one of the first examples of wartime development. They were set up by the Coal Production Council before France fell, but lapsed in the months after Dunkirk when miners were being allowed to leave the industry. They were revived in March, 1941, and by the summer were in existence at almost every pit. The Pit Production Committees have discussed questions affecting production at the colliery, such as mechanisation, transport and specific suggestions from mine-workers. The Essential Work (Coal-Mining Industry) Order of 1941 made the Pit Production Committees, in co-operation with the National Service Officer, responsible for interviewing and reporting workers who had been persistently late or had unreasonably absented themselves from work. These Pit Production Committees, like the Yard Committees in the shipbuilding industry, created a precedent which it was possible to follow in the engineering industries.

Growth in Engineering.—Discussions on the subject of joint consultation on production began early in 1941 between the Amalgamated Engineering Union and the Engineeering and Allied Trades Employers' Federation. The Nazi attack on the Soviet Union gave impetus to the movement, while the Tanks for Russia Week helped to produce enthusiasm. Workers who had so far remained passive, who had been continuously " browned off," began to feel that the war was their own responsibility. All sorts of new committees and sub-committees which embodied the new spirit were established. The growth was specially noticeable in the aircraft industry, where the widespread system of payment by results made the workers " production conscious." The shop stewards were the prime movers in creating the new Production Committees, and the unofficial body in which they were organised was the Engineering and Allied Trades Shop Stewards' National Council. This Council held a conference in London, which was the first important expression of the workers' growing interest in production.

In October, 1941, the Midland Regional Board recommended the engineering firms in the Midland Region to set up Joint Production Inquiry Committees, wherever a desire for such committees was expressed and " wherever it was felt that they could usefully function." The purpose of the Committees would be to provide for an " exchange of views between representatives of management and workpeople on points of mutual interest affecting output."

Collaboration at the factory level was constantly enlarging its scope throughout the period even though organisational forms differed widely, and the way was gradually being made clear for the official agreements which are considered in the next section. Government Departments were visited by factory delegations on many occasions during the winter of 1941-1942, and the desire to canalise such representations may have been one of the motive forces behind the official agreements. Another cause was probably the desire on the part of the Trade Union leaders to guide and give form to the more or less spontaneous developments of the time.

Achievements of Committees

J.P.C.s can be said to have three main objectives: firstly, to promote enthusiasm for the production effort; secondly, to provide a channel for the dissemination of information; thirdly, and most important, to suggest specific ways of increasing efficiency in munition factories. Many of the early J.P.C.s which were formed, on the workers' side, from the Shop Stewards' Committee suffered from being too small and too isolated from the individual employee. They consequently did little to create the real enthusiasm which is a condition of success for any production drive.

The open elections which have taken place since the agreement have helped to remedy this. Any employee is entitled to make nominations, and after

Joint Production Committees

the candidates have been approved by the Trade Union they are normally put forward for open election by secret ballot. Regular reporting back is an important means of keeping enthusiasm alive. It is certainly impracticable to call regular meetings of the whole factory every time the J.P.C. meets. But various methods of sustaining enthusiasm can be utilised. Shop committees have already been noted as one means whereby decisions on matters of specific interest to one shop can be made known. Regular reports in a works bulletin can also assist, suggests the P.E.P. broadsheet.

Giving information to employees about their work is one means of arousing their interest. It has been proved time and time again that the spirit of factory workers has been better where they have been taken into the confidence of the management, and the J.P.C.s have been useful channels for conveying the required information. At one large aircraft factory, for instance, the management gave a frank and full explanation to their employees, through the J.P.C., about the inevitable hold-ups consequent upon the introduction of a new type of plane.

The engineering industries have expanded two- or threefold since the war began, but the number of skilled managers has not been capable of proportional expansion. The result has been an acute shortage of managerial ability. Workers, particularly skilled workers of long experience, may be able to help to offset this shortage of managerial ability by making really practical suggestions for improvements in method.

Co-ordination of Committees

J.P.C.s are purely advisory. It is not intended to have voting at meetings, and their functions are in no way executive. Nevertheless, the workers' representatives on a J.P.C. may disagree profoundly with the view taken by the management. Their only recourse in such circumstances is to refer the matter to Trade Union District Committees. Apparently proposals have now been drawn up, as a result of conferences of engineering unions held by the General Council of the Trades Union Congress, for Joint Trade Union District committees to be set up in industrial centres with the job of assisting and overseeing the work of the local J.P.C.s. The trade unions are in a position to place the matter before the Regional Board upon which the Unions are represented.

Action to associate J.P.C.s more closely with Government authorities concerned with production has been recommended by the Citrine Committee on Regional Boards and agreed in principle by the Minister of Production. It is pointed out in the Report that J.P.C.s in Royal Ordnance Factories are able to receive guidance and information from the Ministry of Supply, and suggested that the J.P.C.s should be able "to bring production problems to the notice of the Regional Boards so that they may be considered and resolved locally or in the absence of local settlement referred to headquarters." Not all the questions considered by J.P.C.s, *e.g.*, design, come within the purview of the Regional Boards, who could only act, on such issues, as clearing houses for a two-way traffic of suggestions and advice. The Regional Board may, where appropriate, refer questions raised by J.P.C.s to District Committees which are to consist of equal numbers of representatives of workpeople and employers appointed by the Minister of Production. It is expressly stated that questions which are capable of adjustment within the factory and matters such as wages and conditions of employment should not be referred to the District Committees or to the Regional Boards. The proposals of the Citrine Committee may help to establish closer co-ordination between the J.P.C.s in given centres which in some cases have already arranged for joint meetings, and cement the J.P.C.s ever more firmly as a feature of national policy.

J.P.C.s are such a new development that their strength and significance cannot adequately be judged, and there are still many obstacles in the way of their success, which in individual cases will depend greatly on the personality of the chairman.

MACHINERY IN REQUISITIONED WORKS

At a recent sitting of the House of Commons, SIR GRANVILLE GIBSON asked the Chancellor of the Exchequer whether he was aware that much dissatisfaction existed among firms whose premises had been requisitioned that under a ruling made by his Department no compensation would be payable towards the cost of dismantling machinery and re-erecting it in the requistioned premises at the termination of their occupation by a Government Department. Would the Chancellor reconsider the ruling made, in view of the additional expense to which such firms would be put in returning to their own premises?

In reply, SIR KINGSLEY WOOD said: The compensation payable in respect of the requisitioning of premises is governed by Section 2 of the Compensation (Defence) Act. If premises are requisitioned and the owner is directed to remove any machinery therein and decides to store it, the cost of dismantling, transporting and storing it elsewhere, together with the cost of subsequently re-erecting it in the premises, is paid. If, however, the owner decides to re-erect it elsewhere, the cost of dismantling, transporting and re-erecting it in the new premises is paid, but in that event the cost of a second dismantling and re-erecting cannot be treated under Section 2 (1) (d) of the Act as an expense incurred for the purpose of compliance with a direction by the Government.

Foundry Dust Problem.—American Magnesium Corporation, Cleveland, reports it has found in its foundry a new solution to the old problem of free dust and sand settling into moulds and causing rejects, in the form of a new heating and ventilating system. The equipment used consists of 10 Carrier heat diffusers, supplying 135,000 cub. ft. of outside air per min. to the foundry.

BIRTHDAY HONOURS

WAR SERVICE TO INDUSTRY

Service to industry and the nation is acknowledged in the list of Birthday Honours conferred by the King, from which we give the following extracts:—

Baron

MR. JOHN MAYNARD KEYNES, well-known economist and member of the Chancellor of the Exchequer's Consultative Council.

Baronet

SIR FRANCIS L'ESTRANGE JOSEPH, chairman and managing director of Settle, Speakman & Company, Limited, and associated enterprises in North Staffordshire, including the Stafford Coal & Iron Company, Limited. His directorships include membership of the boards of the London, Midland & Scottish Railway, the Midland Bank, the Rio Tinto Company, B.S.A. Company, and the Birmingham Railway Carriage & Wagon Company. He was a founder of the Central Pig-iron Producers' Association and the Basic Iron Producers' Association, and is a Past-President of the Federation of British Industries.

Knights Batchelor

MR. JOHN McLEAN DUNCANSON, Deputy Iron and Steel Controller. Mr. Duncanson joined the Iron and Steel Control prior to the outbreak of war as Director of Heavy Steel, including semi-finished steel and shell steel. He was later appointed to the position of Assistant Controller of Steel Supplies. Mr. Duncanson is a director of the Steel Company of Scotland, Limited, and deputy-chairman of R. Y. Pickering & Company, Limited. He is also on the board of the Glasgow Railway & Engineering Company, Limited.

MR. GEOFFREY DUKE BURTON, Director-General, Mechanical Equipment, Ministry of Supply. Mr. Burton is chairman of William Jessop & Sons and B.S.A. Tools, Limited, and managing director of the B.S.A. Company.

MR. ARTHUR WILFRID GARRETT, Chief Inspector of Factories, Ministry of Labour.

MR. HOLBROOK GASKELL, director of Imperial Chemical Industries, Limited.

MR. ROBERT STEWART JOHNSON, chairman since 1940 and managing director since 1922 of Cammell Laird & Company, Limited, shipbuilders and engineers, Birkenhead, and a director of the English Steel Corporation, Limited. Mr. Johnson served his apprenticeship with Harland & Wolff, Limited, Belfast, later transferred to Workman, Clark & Company, and joined Cammell Laird & Company as a director in 1920.

MR. THOMAS SINCLAIR KENNEDY, general manager, Glenfield & Kennedy, hydraulic engineers, Bombay.

MR. FREDERICK CHARLES YAPP, deputy chairman of Vickers-Armstrongs, Limited, and acting chairman of the English Steel Corporation, Limited.

C.B.

DR. HERBERT JOHN GOUGH, Deputy Controller-General, Research and Development, Ministry of Supply. Formerly Director of Scientific Research at the War Office, Dr. Gough was apprenticed to Vickers, Limited, and joined the staff of the National Physical Laboratory in 1914. He was Superintendent of the Engineering Department of the N.P.L. from 1930-38, when he went to the War Office. He has contributed some 70 to 80 Papers on engineering subjects to the Proceedings of the Royal Society, in addition to numerous Papers read before the Iron and Steel Institute, the Institute of Metals, and other scientific bodies.

LORD RIVERDALE (for services to the Empire Air Training Scheme). Lord Riverdale is managing director of Arthur Balfour & Company, Limited, Sheffield, and chairman of High Speed Steel Alloys, Limited, Widnes. He has presided over many Government Committees of Inquiry and led several Economic Commissions abroad.

K.B.E.

MR. CHARLES GALTON DARWIN, Director, National Physical Laboratory, Department of Scientific and Industrial Research.

C.B.E.

MR. R. S. CHIPCHASE, chairman and managing director, Tyne Dock Engineering Company, Limited, South Shields.

COMMANDER E. R. MICKLEM, general manager, Vickers-Armstrongs, Limited.

O.B.E.

COMMANDER PETER DU CANE, managing director, Vosper, Limited, shipbuilders, engineers, and iron-founders.

MR. J. D. FARMER, director, J. & E. Hall, Limited, Dartford.

MR. F. G. PERCIVAL, general superintendent of mines, Tata Iron & Steel Company, Limited.

M.B.E.

MR. ARTHUR COLLINS, outside manager, Vickers-Armstrongs, Limited.

MR. A. GRAVELL, superintending engineer, Nahan Foundry, Sirmur State.

MR. J. B. PATERSON, works manager, Beardmore Diesels, Limited, Dalmuir.

NEW TRADE MARKS

The following applications to register trade marks appear in the "Trade Marks Journal":—

"MANGCROSS"—Electrodes for electric arc welding. QUASI-ARC COMPANY, LIMITED, Grosvenor House, Park Lane, London, W.1.

"ELKONSTAN"—Parts of scientific, electrical, and weighing apparatus, etc. MALLORY METALLURGICAL PRODUCTS, LIMITED, 78, Hatton Garden, London, E.C.1.

SCRAP COLLECTION AND TREATMENT

REPLACING IMPORTED SUPPLIES

Iron and steel scrap is essential in the making of iron and steel. With the loss of imported iron ore the need for scrap is clearly increased, particularly when it is realised that more than 500,000 tons per year of scrap was imported during the early part of the war from the United States of America. It is to make good this deficiency in particular that the scrap campaigns have been launched.

The Ministry of Works and Buildings have undertaken the responsibility of organising the special campaigns for obtaining scrap of a special nature. These campaigns fall under three particular headings: (*a*) "Blitz" scrap; (*b*) railings; and (*c*) scrap falling under the National Survey.

The function of the Iron and Steel Control has been to supervise and to ensure the proper distribution of scrap. Early in the war consideration was given to the degree of control which should be exercised over the scrap industry and methods for the obtaining of scrap. It was felt that in view of the large organisation which would be required to take complete control over the securing and treatment of scrap that the Iron and Steel Control should use such channels as were available without attempting to keep a direct control over every facet of the organisation. To illustrate this it is sufficient to say there are at least 50,000 works producing scrap; there are 4,000 merchants licensed by the Control for the handling of scrap, and nearly every household is a producer of scrap. At the other end of the scale there are over 2,000 works using scrap as raw material.

The main control over scrap lies in the licensing of sale and acquisition. This is designed primarily to ensure that supplies are directed by quality and quantity to the places most in need of them.

Transport Problems

Transport is a most important portion of the operations. There are tens of thousands of wagons permanently engaged in the transport of scrap and it is in this connection that some of the greatest difficulties arise. The lighter varieties of scrap are most wasteful of transport, *e.g.*, railings and turnings when loaded direct from the source frequently do not occupy more than 2 tons of the loading capacity of a 10-ton wagon. It is for this reason that the policy of the Control has been directed at achieving the treatment of scrap when possible as near the source of its arising as possible, either by the provision of equipment at the works where it arises, *e.g.*, breakers for steel turnings at engineering shops, or by routing through the yards of merchants able to sort and treat scrap. It is particularly important to achieve so far as possible the proper utilisation by quality of scrap in the consuming works.

The developments of war industry have made this problem more acute even than in the normal state of the industry and it is from this that many of the most difficult problems arise. Much of the scrap now arising from the campaigns carried out by the Ministry of Works and Buildings is of a light nature, which has a limited use when the industry is at its maximum pressure. The measure of the desirability of scrap to the iron and steel industry is broadly the rate at which it can be handled into a furnace by means of mechanical equipment. It will be seen, therefore, that scrap which is light tends to occupy this equipment for a longer period than that scrap which is in a heavy form. All scrap, it must be made clear, can be used for the making of iron and steel, consequently even the least suitable scrap is only deferred in use to a time when the industry is in a greater degree of shortage of raw material.

Looking Ahead

The broad picture of scrap supply at present is that through the campaigns of the Ministry of Works and Buildings the deficiency of imported supplies is being met, but to some extent in a variety which is least suitable for the maintenance of peak outputs than that which was imported previously; the gap between the normal arisings of scrap and the present consumption of scrap is being made good by scrap of a capital nature which it is hoped will last for a considerable period, but which must come to an end or at least be limited in supply after some date in the future. The large gap between the present supply and what may be regarded as normal arisings makes it clear that every effort should be made while labour is available to create as big a stock as possible to enable the industry to operate even after the aggregate collection ceases to meet the demand.

It is for this latter reason that the policy of the Control is to create a series of dumps throughout the country which can provide a reserve.

OBITUARY

MR. J. HAMILTON GIBSON, consulting engineer and a past-president of the Liverpool Engineering Society, died on June 4, aged 73.

MR. JOHN SMITH, head of the National Metal Company, Limited, Glasgow, and the Beacon Engineering Company, Limited, Manchester, has died at the age of 67.

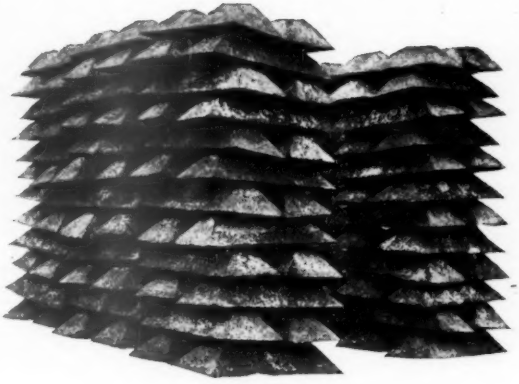
MR. T. STEPHENSON, of Blyth, principal of T. Stephenson & Son, metal merchants, has died at the age of 61. He had been a member of Blyth Corporation for 17 years.

MR. E. SUREN, iron, tinplate, and metal merchant and exporter, died recently at his Hampton Wick, Middlesex, home, at the age of 85. He began the business in Billiter Square, London, nearly 50 years ago. His son, Mr. H. L. Surén, is continuing the business at 41, New Bond Street, W.1.

LT.-COL. CECIL ALLEN, D.S.O., who has died, aged 58, at Sydney, Australia, was formerly associated with the Sheffield steel trade, and for a number of years was a director of Henry Bessemer & Company, Limited. Bessemer built his works in association with Mr. J. D. Allen, grandfather of the late Lt.-Col. Cecil Allen and father of Sir Charles Allen, who afterwards succeeded to the chairmanship of the company.

STANTON

PIG IRONS *are* MACHINE CAST



The excellence of Stanton, Holwell and Rixons pig irons seemed to leave no room for improvement until Machine Casting came along. This method of manufacture eliminates sand, eliminates sows and produces a pig which is 100% iron and free from coarse graphite. It is clean working and economical of fuel in the cupola. Stanton Machine Cast Pigs have a shape which makes for easier handling and better stacking.

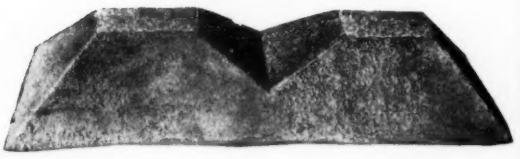
Specification

Weight	...	80—90 lbs.
Length	...	22 inches
Width	...	8½ inches
Thickness	...	3¾ inches

(at notch 2 inches)

New shape
Better stacking

The chemical analysis and well-known physical properties of each brand remain unaltered.



A modern Pig for modern needs

THE STANTON IRONWORKS COMPANY LIMITED, NEAR NOTTINGHAM

COMPANY NEWS

(Figures for previous year in brackets.)

Derbyshire Stone—Dividend of 10% (same).

Ruston & Hornsby—Ordinary dividend of 12½% (same).

Whitehead Iron & Steel—Final dividend of 10%, making 20% (same).

Gaskell & Chambers—Net profit, £21,688 (£16,177); ordinary dividend of 10% (same).

Triplex Foundry—No dividend on the ordinary shares for the year ended March 31 (5%).

Whessoe Foundry & Engineering—Final dividend of 30%, making 40% for the year to March 31 (same).

Keith Blackman—Net profit, £43,752 (£38,414); dividend of 20% (17½%); forward, £46,524 (£38,772).

F. H. Lloyd & Company—Net profit, £14,815 (£39,981); final dividend of 5%, making 8% (10%).

Callender's Cable & Construction—Final dividend of 10% on the ordinary capital, making 15% (same).

Amalgamated Metal Corporation—Dividend of 3½% on the ordinary shares for the year to March 31 last (6%).

G. Hopkins & Sons—One year's dividend on the 6% cumulative preference shares from July 1, 1940, to June 30, 1941.

John Harper & Company—Net profit for year to March 29 last, £27,476 (£26,467); final dividend on the ordinary shares of 10%, making 15%.

Beyer Peacock—Profit for 1941, £51,283 (£53,377); forward, after preference dividend payments, £51,104 (£99,571). Preference dividend is paid to June 30, 1934.

Cannon Iron Foundries—Interim dividend on the ordinary shares of 5% in respect of the nine months to June 30, the first payment since 10% in respect of 1936-37.

Anglo-Greek Magnesite—Company is not carrying on any business, and its charges have been reduced to a minimum. Outgoings in England in 1941 totalled £4,002.

Mason & Burns—Profit for the year to March 31, after deducting depreciation and exceptional war expenditure, £18,156 (£14,171); dividend of 20% (same); forward, £5,893.

Metal Industries—Final dividend of 2½% on the "A" and "B" ordinary stock, making 5% (same). Issue of the accounts to March 31, 1942, is postponed until a later date.

W. H. Baxter—Net profit for the year to March 31, £4,028 (£3,874); dividend of 7% on the preference shares, £1,400; dividend of 10% on the ordinary shares (same), £3,000; forward, £3,560 (£3,932).

British Timken—Net profit for 1941, after charging depreciation, £108,924; to taxation reserve, £60,000; to contingencies reserve, £20,000; dividend of 15% (same) on the ordinary shares, £30,000; forward, £24,635 (£25,710).

Baker Perkins—Net profit for 1941, after depreciation, tax, N.D.C. and E.P.T., £104,719 (£96,969); final dividend of 3½% on the ordinary shares, making 7% (same); to general reserve, £20,000 (same); forward, £85,552 (£75,987).

Siemens Bros.—Net profit for 1941, £241,019 (£262,990), after providing £142,850 for special war-time expenses, £89,578 for depreciation, £4,222 for directors' fees and adequate provision for taxation and contingencies; ordinary dividend of 7½% (same), £183,750; preference dividend, £55,000; forward, £399,620 (£397,351).

Hattersley (Ormskirk)—Profit for the year ended March 31, £78,645 (£79,167), after E.P.T. and all charges other than income tax, A.R.P. expenditure, and fees; final dividend of 11½%, making 17½% (same); written off expenditure on A.R.P., £3,631 (£3,041); to reserve for liability under War Damage Act, £2,500 (£5,000); war contingencies reserve, £5,000 (same); general reserve, £5,000 (nil); forward, £13,117 (£12,677).

PERSONAL

MR. M. H. METCALFE has been appointed deputy general manager of the Carron Company, Falkirk. He was for many years secretary to the general manager, Mr. George Pate.

MR. ROBERT RUSSELL, of the Royal Technical College, Glasgow, has been appointed by Lanark County Council to be Principal of Coatbridge Technical College. Mr. Russell is a member of the staff of the Department of Civil and Mechanical Engineering and Applied Mechanics in the Glasgow College.

MR. CECIL BENTHAM is relinquishing at the end of this year the position of managing director of Henry Simon, Limited, Cheadle Heath, which he has held since 1926. Mr. Bentham will continue as chairman of the company, to whom consequently his wide experience will still be available. Mr. Bentham hopes in this way to be able to devote more attention to matters arising from the changing industrial and commercial conditions of the present time.

Will

HOLT, J. C., of Rochdale, a director of William Brierley, Collier & Hartley, Limited, machinery makers and brassfounders £35,519

NEWS IN BRIEF

THE MINISTRY OF WORKS has collected 1,000,000 tons of iron and steel scrap in the past ten months. Included in this total is 200,000 tons of railings.

CALLENDER'S CABLE & CONSTRUCTION COMPANY, LIMITED, intends to redeem the whole of the issued 4½ per cent. debentures at 110 per cent. on November 30.

FOR LEAVING HIS EMPLOYMENT as a foundry worker to go to work on an allotment, a Falkirk man was fined £5 with the option of 30 days' imprisonment at Falkirk Sheriff Court last week. The offence was committed in contravention of the Essential Work Order.

BECAUSE of the increasing interest which is being taken in silicon bronze, we are asked to state that P.M.G. hardener and ingot metal can, by arrangement with the proprietors of the alloy, Vickers-Armstrongs, Limited, now be obtained from A. Cohen & Company, Limited, 141, Great Dover Street, London, S.E.1.

Acknowledgements to The Wellman Smith Owen Eng. Corp. Ltd. and Electric Furnace Co. Ltd.

SILICA BRICKS

that satisfy the most exacting requirements

TRUE TO SHAPE AND SIZE

PERFECT FINISH

LOW POROSITY

LOW AFTER-EXPANSION

MAXIMUM RESISTANCE TO THERMAL SHOCK

LONG LIFE from furnace linings and minimum stoppage for repairs are factors more vital to industry than ever before. The selection of silica bricks of proved reliability and consistently uniform quality is fundamental to maximum furnace output. G.R. silica bricks are produced in large, modernly-equipped works where a rigid system of control is continuously applied at every stage of manufacture. It is also important to note that the famous G.R. silica brands are made in works so situated that a minimum of transport is involved in delivery.

LOWOOD silica bricks are used extensively in open hearth furnaces where the conditions are most exacting. They ensure maximum life also in converters and electric furnaces.

ALLEN give excellent service in open hearth furnaces and converters, and in glass tanks. In electric furnaces, their true size and shape and high refractoriness-under-load ensure well-fitting roofs.

QUARTEX bricks possess unique qualities and are used in electric furnaces, converters, regenerators and flues of open hearth furnaces; for coke oven repairs, and in glass works.

GENERAL REFRACTORIES LTD.

G.P. 31

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Raw Material Markets

IRON AND STEEL

Supplies of raw materials to the light foundries are ample to meet current requirements. High-phosphorus iron, which in normal times is used extensively in this branch of industry, is coming forward quite freely and it is possible for buyers to obtain supplies in excess of their immediate needs, with the result that many users have quite good stocks on their hands. Coke, too, is in plentiful supply, no delay being experienced in deliveries from South Wales, Durham and other sources of supply. Conditions in the light-castings branch are far from normal, owing to the restrictions placed on business. Thus demand for high-phosphorus iron from this trade has fallen away to a substantial degree. In other directions, however, this iron is moving away quite freely, as it is proving a valuable substitute for other qualities which are in short supply.

The shortage of hematite ores makes it difficult to increase production of hematite and all the current output is reserved for special consumers, allocations being made by the Control only if no suitable alternative grade is available. It has been found possible to utilise refined iron, high-phosphorus iron and scrap in place of hematite and low- and medium-phosphorus descriptions, so that the pressure on these latter grades has been greatly diminished. Conditions in the heavy engineering section remain as brisk as ever and works are fully employed on urgent contracts, mostly for Government departments. Machine-tool foundries are very active, while many of the jobbing foundries have well-filled order-books. Heavy engineering establishments will undoubtedly continue to play a prominent part in the war effort of industry, but it is unlikely that there will be any material improvement in the light-foundry trade, as few of the works in this category are suitably equipped to cope with the requirements of the Government.

In the earlier stages of the war British steel consumers were able to rely quite extensively on United States manufacturers, but for many months past this source of supply has been denied them and it is not likely to be reopened while hostilities continue. Fortunately, the steps which have been taken by home producers have proved very gratifying and there is no suggestion of a shortage of steel. Distribution is being made carefully, so that our resources shall be wholly at the disposal of the war factories. The demand for special qualities of steel has expanded enormously in recent months. Producers have been hard pressed to keep pace with requirements and it is to their credit that they have succeeded in meeting the urgent needs of the consumers of these grades, which are used for particularly important war contracts. The plate mills are fully committed on orders from the shipyards, wagon and tank makers, etc. The sheet makers are somewhat quieter; only specially licensed orders for galvanised sheets may be accepted, while the demand for black sheets seems to have decreased slightly of late.

NON-FERROUS METALS

The recently concluded agreement between the U.S. State Department, the Metals Reserve Company and the Mexican Government is expected to result in an expansion of production of strategic metals in Mexico. The plan involves minimum purchases by the Metals Reserve Company of 525,000 tons of copper, lead and zinc—75,000 tons of copper, 250,000 tons of lead, and 200,000 tons of zinc. The prices to be paid for these supplies will be high and about equivalent, on a delivered to American market basis, to the current ceiling levels for the metals concerned.

Satisfactory deliveries of copper continue to be made to British consumers and this metal is being used very extensively in the munitions works. From the United States it is reported that the acquisition of frozen stocks of copper by the War Production Board has been vested in the Copper Recovery Corporation of New York, the executive personnel of this organisation consisting of prominent personalities in the copper and brass trades and a representative of the Metals Reserve Company. According to New York advices, production of crude copper and the output by refineries in May were at peak levels in the history of the U.S.A.

In 1941 the United States Government took about 90 per cent. of the Chilean copper output, but since February last the entire production has been earmarked for American consumption, and the U.S. authorities are pressing for still larger supplies. The American Bureau of Mines gives Chile's copper production for 1941 as being 453,594 metric tons, which constitutes a record level. The previous highest output was attained in 1937, when production was some 40,000 tons less than in 1941. The largest of the Chilean copper producers are controlled by American capital.

Negotiations have been completed for the export of Bolivian tin ore to Chile, it is announced from La Paz. The Compania Recuperadora Metalurgica will refine and smelt the tin ore. In America the War Production Board is understood to be arranging further restrictions on the use of tin for non-essential purposes, while consumption of spelter is also being curtailed where possible.

CENTRAL PRODUCTION COMMITTEE

In anticipation of the remodelling of the regional production boards, the central co-ordinating committee recommended by the Citrine Committee has been appointed and has had its first meeting. Its members are:—Mr. N. V. Kipping (chairman), of the Ministry of Production, Mr. A. S. le Maitre, M.C. (Admiralty), Mr. Spencer Summers, M.P. (Ministry of Supply), Sir Allan Gordon Smith (Ministry of Aircraft Production), Mr. E. A. Hitchman (Ministry of Labour), and Sir Percy Mills (Controller-General of Machine Tools). It is expected that the new regional controllers of production will be appointed within the next few weeks, and that the appointments will be announced immediately after the return of the Minister of Production from America.

SPEEDING PRODUCTION

For every Industrial Heat Treatment process there is a Mirrlees Combustioneer to speed the production and cut down the costs.

Mirrlees Combustioneers burn a wide variety of coals satisfactorily—a big advantage at the present time.

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WITH WHICH IS INCORPORATED *THE IRON AND STEEL TRADES JOURNAL*

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'Phone : HIGH WYCOMBE 1792 (3 lines).

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Participating Associations : National Ironfounding Employers' Federation ; British Ironfounders' Association ; National Association of Malleable Ironfounders ; Ironfounders' National Confederation ; British Bath Manufacturers' Association ; British Malleable Tube Fittings Association ; Cast Iron Chair Association ; Greensand Pipe Founders Association of Scotland ; Cast Iron Heating, Boiler, and Radiator Manufacturers' Association ; Cast Iron Segment Association ; National Ingot Mould Association ; Cast Iron Axlebox Association ; Institute of British Foundrymen (affiliated) ; British Cast Iron Research Association (affiliated) ; British Grit Association (affiliated) ; Agricultural Engineers' Association (affiliated).

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BRITISH CAST IRON RESEARCH ASSOCIATION

21-23, St. Paul's Square, Birmingham. 'Phone : Colmore 4274-4275 ; 'Grams : *CIRA.*

Scottish Laboratories :—Foundry Technical Institute, Meek's Road, Falkirk. (Phone : 332.)

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